

Rev. Thomas J. Carroll

CHILDREN
REHAB CODES

Association for
the care of crippled
children

Report No. 7

Identification of School Children Requiring Eye Care

A REPORT TO EDUCATORS AND PHYSICIANS

DR. JAECKLE

Issued by:

THE NATIONAL MEDICAL FOUNDATION FOR EYE CARE

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Association for the Aid of Crippled Children

345 EAST 46TH STREET—ROOM 700

NEW YORK 17, N. Y.

Telephone: OXford 7-3150

President

NEVIL FORD

Executive Director

LEONARD W. MAYO

Assistant Director

STEPHEN A. RICHARDSON

August 3, 1960

NOTICE OF MEETING

of

Subcommittee on Visual Impairments

A meeting of the Subcommittee will be held on Thursday, November 17, 1960, from 10:00 a.m. until 4:00 p.m. in the Board Room of this Association at 345 East 46th Street, New York City. Those in attendance will be guests of the Association at luncheon.

Please return the enclosed postcard.

It is sincerely hoped that you will be present.

Maya Riviere, D.Phil.(Oxon.)
Associate Director
Rehabilitation Codes

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THE NATIONAL MEDICAL FOUNDATION FOR EYE CARE

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TRUSTEES OF THE NATIONAL MEDICAL FOUNDATION
FOR EYE CARE

- ALSON E. BRALEY, M.D., *Professor and Head, Department of Ophthalmology*, State University of Iowa College of Medicine, Iowa City, Iowa
- KENNETH C. BRANDENBURG, M.D.,* *Attending Ophthalmologist*, Long Beach Community Hospital, Long Beach, California
- FRANK D. CARROLL, M.D., *Associate in Ophthalmology*, College of Physicians and Surgeons, Columbia University, New York, New York
- LAWRENCE R. DAME, M.D., *Chief of Ophthalmology*, Franklin County Public Hospital, Greenfield, Massachusetts
- PURMAN DORMAN, M.D., *Chief of Ophthalmology*, Seattle General Hospital, Seattle, Washington
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- HOWARD F. HILL, M.D., *Attending Ophthalmologist*, Thayer Hospital, Waterville, Maine
- MICHAEL J. HOGAN, M.D., *Professor of Ophthalmology*, University of California School of Medicine, San Francisco, California
- CHARLES E. JAECKLE, M.D., *Associate Attending Ophthalmologist*, Hospital Center at Orange, New Jersey
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- BARNET R. SAKLER, M.D., *Assistant Professor*, Department of Ophthalmology, University of Cincinnati College of Medicine, Cincinnati, Ohio
- HAROLD G. SCHEIE, M.D., *Professor of Ophthalmology*, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania
- DERRICK VAIL, M.D., *Professor and Head of Department of Ophthalmology*, Northwestern University Medical School, Chicago, Illinois

*Deceased

Identification of School Children Requiring Eye Care

P R E F A C E

Over thirty-three million children attend school in the United States. It has been estimated that 80 to 85 per cent of their learning is via the visual pathway.

Appraisal of the health of these children helps teachers understand their pupils and identifies problems that require attention. In some instances health appraisal, or some phase of it such as "vision testing," is required by law. Commonly employed health appraisal methods include teacher observation, health histories, medical inspection, and "screening" tests. Of the "screening" tests, among the most frequently used are those intended to identify children with impairment of vision. The ideal procedure would identify *all* children with ocular or visual impairment or abnormality (and select no others), but since "screening" is by its very nature less than an examination by the ophthalmologist, this cannot be accomplished.

The National Medical Foundation for Eye Care has had many requests for information on this subject from educators, ophthalmologists, and other physicians who have the responsibility for the health and the conservation of vision of school children. The pur-

pose of this report is to define the problem for the educator, the general physician, and the ophthalmologist, to help all understand it in their relation to one another.

This report* would not have been possible without the pooled experience of ophthalmologists throughout the country and the helpful suggestions of many physicians in the other branches of medical practice and in public health. The suggestions of many educators, superintendents, principals, remedial reading teachers, guidance counselors, psychologists, health educators, and administrators were helpful and appreciated. Finally, whoever sought information and help from the Foundation, by his inquiry also contributed.

*A report by an ad hoc committee established by the National Medical Foundation for Eye Care: Ralph O. Rychener, M.D., Chairman, *Associate Professor of Ophthalmology*, University of Tennessee College of Medicine; Morton Arnold, M.D., *Chief of Ophthalmology*, Windham Community Memorial Hospital (Conn.); Earl Barrett, M.D., *Clinical Associate in Ophthalmology*, University of Washington Medical School; Curtis D. Benton, Jr., M.D., formerly *Associate in Ophthalmology*, Emory University School of Medicine (Georgia); Samuel M. Diskan, M.D., *Consultant Oculist*, Public Schools of Atlantic City (N.J.); Harold F. Falls, M.D., *Associate Professor of Ophthalmology*, University of Michigan Medical School; Charles E. Jaeckle, M.D., *Associate Attending Ophthalmologist*, Hospital Center at Orange (N.J.); Otto Lippman, M.D., *Consulting Ophthalmologist*, Sight Conservation Program, Austin Public Schools (Texas); Barnet R. Sakler, M.D., *Assistant Professor, Department of Ophthalmology*, University of Cincinnati College of Medicine; Edwin F. Tait, M.D., *Clinical Professor of Ophthalmology*, Temple University School of Medicine (Pa.) (deceased).

Nature and Objective of a School Eye Health Program

Complete ocular examination of every child by the ophthalmologist, beginning in infancy and repeated periodically, is an ideal goal which, while not impossible, is not yet universal practice. For lack of it too many children start school with serious permanent impairment of vision, and even blindness in one eye, which could have been prevented. Until parents recognize the need of every child for periodic ophthalmological examination, it is advisable to identify the child who particularly needs attention.

The specific responsibility for this resides in the parents. The family physician has the primary medical responsibility. The school, however, has a vested interest in the health and physical status of the child, since these factors affect the spread of disease and the ability of the child to acquire an education. In the case of the public school, to ascertain that the child is able to benefit from his educational opportunity is to protect the public investment. The parochial school has a comparable interest. Because sight is the most important of the senses in learning, the school has taken a particular interest in the health and function of the visual system. Screening for ocular diseases and defects, however, is but a part of the general *medical* program of screening school children for physical defects and evidence of disease. The eyes and the brain are but parts of the *whole child*.

The general school health program will include eye health education, special provision for the needs of the partially sighted child, and the provision of emergency services for eye injuries. These subjects will not be discussed here. The identifi-

cation of children for referral for medical care, however, requires special consideration.

A school health program merely augments the general medical care pattern of the community. The primary objective of the eye health program in the school should be to identify and refer for medical examination those children who probably have an abnormal condition of the visual system* from whatever cause. There are three ways of identifying these children: 1) *evidence* of the abnormal may be *observed by parents or teacher*; 2) *signs* may be detected on *medical inspection* by the school physician or *physical examination* by the family physician; 3) *functional* tests may be applied by the school physician or by the nurse or a layman under the physician's direction. These combined constitute an eye screening program. The significance of each will be apparent after consideration of the bases for medical referral.

Function of the Screening Program

The function of the screening program is to identify children who require examination by the physician. It is not solely to find the children who require treatment, or to establish definitely which children have or do not have an abnormal condition, or even whether poor reading has a visual basis. These are the functions of the *examining* physician, i.e. the ophthalmologist whom the parents consult. It is not the function of the screening program merely to identify the child with a refractive error (defect in focus) or "visual defect." *The child may have normal vision and yet have ocular disease urgently requiring medical attention.* He may have less than normal vision, yet the necessary examination may prove him to require no service other than medical diagnosis. He may have hyperopia, myopia, astigmatism, or "muscle imbalance"; although that child *may need no glasses*** or other treatment of any kind, he will

*The visual system includes the eyes and related structures and their motor and sensory pathways of the brain. An abnormality may be functional or structural.

**Eyeglasses do not prevent disease or "conserve vision," nor (with the exception of some children in whom a defect in focus is a causative factor in "crosseyes") do they prevent blindness. Failure to use them does not cause disease.

require medical ocular examination to establish a diagnosis and to permit interpretation of the child's condition to the parents.

Who should be referred? All will agree that a child with *disease* affecting the visual system should be referred to the physician. It is universally recognized that those children whose *acuity of vision is impaired*, whether due to refractive state (focus of the eyes) or to disease, should be referred for examination. Any condition which commonly *impairs binocular vision* or handicaps the use of the eyes for *close work* warrants examination and evaluation. How shall these children be found? Functional tests alone will not detect all of these conditions. Children may experience but not report symptoms. Some conditions do not give rise to ocular signs.

It will be evident that in addition to the operational phase of a school eye health program, there must be an educational phase and adequate follow-up. The parents, school administrators, teachers, guidance counselors and other staff personnel, must all understand the nature and objective of the screening program. The parents must be encouraged and educated to take the child for examination when this has been advised.

Operation of the Eye Health Program

In screening for ocular conditions physicians are attempting something quite different from screening for a single disease, e.g. tuberculosis. In ocular screening an attempt is being made to search for a number of conditions affecting an organ system. It is, in fact, multiple screening, and as such it is not to be expected that any single procedure or test will serve to screen for the many diseases and abnormalities which may affect the visual system.

In the search for effective identifying procedures, tests and instruments have sometimes been overemphasized. As a result they tend to acquire a false authority. Parents who have observed evidence of ocular abnormality, who "have noticed that the eye turned," or that the child complained of headaches, or "squinted," have reported to the ophthalmologist that they "waited to see what the school would find" the next year.

Parents have sometimes even deferred seeking medical care indefinitely because the screening was negative, even though symptoms of visual difficulty were observed. Such instances are known to every ophthalmologist, no matter what screening procedure has been followed in his community.

Observation of the Child

Whenever parents observe in their children ocular symptoms, or signs which they think may be ascribable to an ocular basis, they should seek medical advice without waiting for the results of any school test. Red eyes, crusts on the lashes, styes, discharge, swelling of the lids, head tilt, all indicate that medical examination is needed and parents should consult their family physician or their ophthalmologist. When excessive blinking or frowning, "cross eyes," "wall eyes," deviation of the eye toward or away from the nose, or "cast" are present, the family physician will usually recommend consultation with the ophthalmologist. Such signs may be evidence of ocular disease, or of a need for glasses, or of brain or general disease. Parents should recognize that signs and symptoms, even more than failure to pass tests, are the indication for seeking medical advice. Therefore parents must be taught what to look for.

Eye signs may be observed by the teacher, who may see what the parents have failed to see, or failed to act upon, or not had the opportunity to see—e.g., squinting to see the blackboard. The child may complain of headache—which *may* be due to the eyes.* A child may hold books or objects close to the eyes. The teacher should report her observations to the principal or the school medical department, who in turn should notify the parents. The teacher must learn what to observe.

Testing by the school nurse or technical personnel is not required when eye signs have been observed; *signs and symptoms* are an indication for *examination* regardless of the result of any technical screening test. Such tests are not diagnostic or even definitive. Since they are performed only to select children for referral to the physician, it is unnecessary to carry out tests

*It should never be assumed prior to examination by a physician that headaches are due to a need for glasses or even to any ocular condition.

on children whose need for medical care is already evident. The child is entitled to qualified medical opinion.

Poor progress in learning to read may have an ocular basis. When other causes are not apparent, referral for ophthalmological examination is justified even in the absence of specific ocular signs and symptoms.*

The importance of teacher observation cannot be overemphasized. In calling upon her for this, no new additional burden is being placed on the teacher. In the course of their training all teachers have been taught, and in teaching all teachers practice observation of the child for signs of physical defects and impaired function. There is danger of ascribing to batteries of screening tests a value which they do not have, and in doing so, overlooking and failing to encourage teacher observation.

Whenever, for any reason, a child comes under the observation of the school nurse, she too has the opportunity to note signs of eye trouble. Her basic professional training prepares her for this, her interest and awareness will alert her. She should have medical guidance and advice.

Many schools have found it helpful to hold an annual teacher-nurse conference early in the school year. Here mutual problems may be discussed and the nurse may orient the teachers regarding significant observations, including ocular signs.

Medical Inspection

An examination of the eyes is part of every general medical examination. The physical inspection by the school physician is no exception. If the child is presented to the family physician, his general diagnostic examination will include external examination of the eye, examination of the interior of the eye with the ophthalmoscope, examination of motor function (including convergence), and the evaluation of acuity of vision. The school physician's inspection is qualitative rather than diagnostic in character, but is similar in scope, except for ophthalmoscopy, which in general has not been included.

*The visual system and difficulty in learning to read will be the subject of a separate report.

Whenever the school physician observes any abnormality, he will advise referral for examination by the family physician or the ophthalmologist, as the condition may indicate. His observation will be concerned with conditions requiring diagnosis and evaluation, and perhaps treatment, which may be medical, optical, or surgical. When he finds any indication for the referral of a child, the child requires no screening tests. The physician has identified the child as one requiring medical eye examination. Although some he designates may also be identified by parent-teacher-observation or by screening tests, no test or group of tests can be substituted for the general physician's examination. In the school, as in the office, he has responsibility for supervision of the nurse or any other assisting personnel.

Tests and Testing

Functional Tests

Parent-teacher observation and medical inspection will not identify all children who should be referred for ophthalmological examination. Children do not always recognize or voluntarily report their symptoms; signs of trouble are not always present, and when present are not always observed by parents or teachers. Some conditions can only be detected by functional tests. They are always indicated for children not previously found to require referral because of symptoms or signs. If applied to children already identified for referral by teacher observation or medical inspection, the tests may or may not select these children for referral. This is immaterial, for symptoms and signs are conclusive and beyond confirmation by a test. If a screening test of such a child is negative, it in no way controverts the indication for referral of a child showing signs or symptoms.

Screening tests are a substitution of method for professional knowledge. They are not diagnostic. They are procedures designed to be applied by someone not an expert, to sort out those who probably have abnormalities from those who probably do not, without the exercise of judgment by a qualified

expert. The effectiveness of such a procedure depends upon the selection of appropriate tests by the qualified expert and their proper application by the assistant on a pass or fail basis.

Criteria for Tests

The selection of appropriate tests requires that they be critically evaluated. The following criteria are suggested for the evaluation of screening tests.

1. *The test should be valid.* It should test function and bear relation to clinical knowledge.
2. *The test should be reliable.* It should give similar results on repetition.
3. *A nurse or layman should be able to administer the test with a minimum of training.*
4. *The test should consume a minimum of time consistent with ascertaining the necessary information.*
5. *The test should lead to a minimum of "over-referrals."*
6. *The method should avoid the appearance of indicating diagnosis or degree of defect, either to the parents or to the lay persons administering the test.**

Parent-teacher observation and medical inspection should be supplemented by such tests that the total program results in the minimum of failures to refer.

Visual Functions

The visual functions are:

1. Central vision—the ability to perceive and to discriminate the detail of objects.
2. Accommodation—the ability to adjust the focus for near vision.
3. Binocular vision—the ability to see the same object with both eyes simultaneously and singly.
4. Peripheral vision—the ability to perceive objects not looked at, objects in the periphery of the field of vision.
5. Color vision—the ability to perceive color.

*In addition to these medical criteria, the public interest requires that costs be justified.

1. Test for Acuity of Central Vision

The child in school must be able to see detail of small objects and printed symbols. The measure of this ability is the acuity of vision. Reduced acuity of vision is the most frequent impairment of ocular function.

Reduction of acuity of vision may be caused by (1) disease involving the eye itself, (2) disease involving a nerve pathway in the brain, or (3) a refractive error (defect in focus). Since acuity of vision in normal persons varies over only a narrow range, it is possible to establish a standard for testing; failure to meet the standard is clinically significant. Acuity of vision is of diagnostic significance to the physician. Its determination is a part of every complete physical examination and of every ocular examination.

Impaired central vision cannot be relieved in every case, but it is always an indication of abnormality, which may be refractive error or organic pathology.

Impaired vision despite proper glasses is always an indication of disease. Such disease may have run its course with impaired vision the result, or it may be active; it may cause permanent loss of sight, or it may present a threat to life itself.

When the physician examines the child he determines the acuity of vision. *In screening*, the object is *not* to determine exactly the child's acuity of vision, but to classify him as to whether his acuity of vision is normal or not normal—can he read the test line? When so administered the Test for Acuity of Vision can be given to most children in less than one minute, regardless of what instrument or chart is used. *The test does not distinguish between refractive error and organic disease.*

The test for acuity of vision is clinically valid. It is highly reliable. It can be administered with little training. It requires a minimum of time. A test of central vision is a part of every screening procedure ever devised and is incorporated in every commercially available "test" or instrument. The visual acuity test identifies not only more children requiring referral than any other single test, but the majority of all children requiring referral.

The first to promulgate the scientific concepts of acuity of vision and to introduce scientific standardization of visual acuity was the Dutch ophthalmologist, Herman Snellen. His table of "Optotypes" for *determining the acuity of vision* was first published in 1862.^{1*} On this Snellen Test all subsequent work has been based. The test is performed with the subject at a physical distance of 20 feet from a chart of letters not only of graduated size, but of specific scientific construction.**

There is no substitute for this test. Tests employing charts which have been designed for use under conditions other than with a physical distance of 20 feet between subject and chart are not Snellen Tests and should not be so described.

In using the Snellen letters for a *screening test*, only those lines which are to be used for a standard are required. Vision of *each* eye is tested separately; if the child has glasses, the test must be done with the glasses. In screening, nothing is gained by testing without glasses children for whom glasses have previously been prescribed.

Whenever the acuity of vision is impaired in either eye, the child should be referred for ophthalmological examination. Acuity may be considered impaired if it is less than 20/30 in either eye in grades 1 to 3, and less than 20/20 in either eye in school grades 4 and above.† If one eye meets this average standard, but the other eye is decidedly *better*, the child should also be referred, for in the individual child the better eye should be taken as the standard. Such difference in the eyes in the lower grades especially may indicate a potential source of trouble. (The adoption of lower standards permits conditions actually detectable by the test to escape identification and so provides the occasion for criticism of the test itself.)

*See page 32 for references.

**SNELLEN's TEST TYPES consist of letters each of which is of such a shape that it can be enclosed in a square whose size is five times the width of the lines composing the letter, and the width of each line is such that it subtends a visual angle of 1 minute when the letter is at a specified distance. (This angle is based on certain anatomical and physiological properties of the eye). The largest letter is so constructed that its elements form this angle at 200 feet, the smallest that its elements form it at 15 feet, and the rest of the letters at successive intermediate distances. Each line of letters is designated by this distance. The normal person should be able to read each of these letters at the respective designated distance.

To determine the acuity of vision, the subject, at a distance of 20 feet from the chart, reads the smallest letters he can. His acuity is then recorded by stating the distance at which the test has been done and the designated distance for the line he reads. Although conventionally these two numbers are recorded as if they were a fraction (20/70, 20/20, 20/40, etc.) this notation is not a fraction, but a short method of reporting two facts. Thus if the acuity is reported "20/70", it is a statement that the subject was *tested at 20 feet and could read the "70 foot" letters*, but none smaller. The physical test distance of 20 feet, of course, was not chosen arbitrarily, but was adopted by international convention for physiological reasons. Testing with "optically compensated" instruments, like the stereoscope, which employ charts physically close, are not equivalent substitutes.

†These standards are average normals for the respective age groups. Although acuity is a physiological variable the limits are so narrow that when deviation occurs its significance should be determined.

2. Convex Lens Test

Practically everyone has some refractive error, but not all require glasses. Refractive errors may cause impairment of acuity of vision, or discomfort and blurring in reading, or both. In children most refractive errors requiring glasses cause impairment of acuity of vision. Some refractive errors, such as hyperopia of moderate amount, may not impair distance visual acuity. They may cause discomfort or blurring of vision in reading, of which the child may or may not complain, or difficulties which the parent or teacher may or may not observe. The use of a test to detect such hyperopic defects is justified. The child may require no treatment, but should nevertheless be examined by the ophthalmologist.

Hyperopia may be detected by a functional test known as the "Convex Lens Test."* A pair of glasses with convex lenses is worn by the child while with *both* eyes open and uncovered he is asked to read the standard test line of a Snellen or symbol E chart. If under these conditions he *reads* the test line, he has *failed* the test. (He has a refractive error, hyperopic in nature and of an order approximately equal to or more than the power of the lenses used in the test.) These convex lenses will blur the vision of the child with no refractive error or the child with a small degree of hyperopia; he will be *unable* to read the test lines (20/20 above the third grade, 20/30 in grades 1 to 3) under these conditions, and *passes* the test. He should not be referred for examination. The test requires only a few seconds.

The convex lens test should be performed only on children whose vision is found to be *unimpaired* in either eye by the test for acuity of vision. It should be clearly understood that the convex lens test detects a refractive condition for which the child is able to compensate for clear distant vision and frequently for clear near vision, and which may or may not cause symptoms or be an obstacle to sustained clear near vision for prolonged periods in school. The need for glasses in such a condition is something to be determined upon examination.

There is no scientific basis for determining the degree of hyperopia which should be the basis for referral, other than the clinical experience and judgment of ophthalmologists. A low degree of hyperopia is normal in a child. Ophthalmologists generally approve the use of lenses of the order of +1.75 diopters** for this test. This does not mean that all children

*Skiascopy (or skiametry) as a means of detecting refractive errors has been considered by many ophthalmologists who have studied this problem. To justify such a relatively time-consuming clinical procedure, dependable research should first show conclusively the need for it in a school system where teacher observation, acuity test with a 20/20 passing standard and a convex lens test are all utilized.

**Recommendations have varied between +1.50 and +2.50 D.S., (2,3,4,5,22,29,30)

with this degree of hyperopia need treatment (glasses); but only that hyperopia of this degree merits individual evaluation; most will be detected. No more effective screening test for the condition has been devised.

The Convex Lens Test is based on our scientific knowledge of refraction. Reliability is high. When applied to those children who pass the Test for Acuity of Vision, a $+ 1.75$ lens will probably screen out about one-tenth as many children as does the Acuity of Vision Test.^{4,5}

In assaying the importance of the Convex Lens Test as a screening test it will be remembered that it detects a condition whose presence is never a sign of disease, and never per se leads to injury or threatens the life or sight of the child, but may affect his ability to use his eyes for sustained near vision.

3. "Near Vision" Tests

The child uses his eyes for near as well as distance seeing. In school this is a critical matter. The physician in his diagnostic examination ascertains the state of near vision. Nonmedical authors have frequently laid stress upon the child's use of his eyes for near vision in school and urged the incorporation of various "near vision tests" in the screening procedure. Familiarity with ocular anatomy, physiology and disease is pertinent to this question.

Near vision is dependent on two factors: acuity of central vision (as determined by distance tests), and ability to adjust the focus for the near point—accommodation. Impaired near vision either will be secondary to a condition which causes impaired distance vision, or will be due to inability to adjust for the near point. Those whose distance vision is impaired are detected by that fact. In children, inability to accommodate for a near point will be secondary to hyperopia (which demands more than normal accommodation), or will be a primary impairment of accommodation caused by paralysis or weakness of the ciliary muscle of the eye resulting from systemic disease, including anemia, general debility, and chronic and acute infections. Hyperopia is detectable by the convex lens test. Paralysis of accommodation is extremely rare in children and in practically all cases causes signs which are observable by parents or teachers. The classical and chief cause of paralysis of accommodation is diphtheria, but by no means do all children who have had diphtheria have impaired accommodation.

Near vision acuity tests are of no value in screening unless done at a standard distance (approximating the reading distance) to which the size of the type or test symbol bears specific relation. When a child is presented with test material at the near point and his habitual posture is disturbed, this of itself is distracting and decreases the reliability and validity of the test.

Tests of acuity of vision at the near point are not recommended in school screening because impaired near vision in children is due to conditions for which specific tests are required, as described. Near vision tests do not serve reliably to detect hyperopia, and so are not an acceptable substitute for the convex lens test. Difficulty in reading due to disturbance of binocular vision is not impairment of near visual acuity and is not detected by any near visual acuity test. Almost all cases of impaired near vision are detected by the distance acuity test (Snellen) or the convex lens test.

4. Binocular Vision Tests

In general, strabismus or "cross eyes" is observable by the layman. It is always a serious matter, no matter how much or how little the eye turns. When strabismus is of small degree it may escape lay observation. Most strabismic children and the majority with other disturbances of binocular vision also have reduced acuity of vision, or a refractive error detectable by the convex lens test, or both. Many will have signs observable by the family or the school physician.

Heterophoria or "Latent muscle imbalance" is not of itself faulty binocular co-ordination. Everyone who does not have strabismus has heterophoria; orthophoria ("no imbalance") for distance and near fixation and all intermediate points, is so rare it may be considered non-existent.* *Fusional vergence* compensates for heterophoria and enables the normal individual to see singly with two eyes.

Heterophoria, regardless of amount, is not of itself an abnormality.⁶⁻¹³ Tait,¹¹ in a study of 4,880 ocularly comfortable subjects with no refractive error or with refraction corrected by glasses showed that (lateral) heterophoria for both distance and near fixation follows a typical Gaussian curve ("bell curve"),** indicating that the findings represent either a distribution between physical limits or a result of a learning process. (Figure 1—P. 36)

Distance heterophoria is the measure of the position of the eyes which

*Muscle paralysis of small degree often simulates heterophoria. This is particularly true of vertical heterophoria (hyperphoria). These measurements, therefore, require medical differential diagnosis.

**Distribution from 14 prism diopters esophoria to 16 prism diopters exophoria for distance fixation, and 16 prism diopters esophoria to 28 prism diopters exophoria for near fixation.

results from normal muscle tone (tonic vergence)^{7,11,14}. It is subject to modification by all the emotional and other factors which modify the basic muscle tone of the individual in this as in other respects. It is a postural measurement; it is not a "skill."

Heterophoria at the near point is not a measurement of a function, but a combination of functions, a product of three variables: tonic vergence, proximal vergence (a physiological variable only), and accommodative vergence, which has a wide physiological variation.^{11,14-16}

Fusional Vergence. The lateral distance heterophoria indicates the demand that is made on fusional vergence for the maintenance of singular binocular vision.^{6,7,11} It is necessary for the physician to know the heterophoria, and the distance between the centers of rotation of the eyes, to evaluate the adequacy of the fusional vergence, but the amount of the heterophoria is not evidence of the adequacy or inadequacy of the fusional vergence. Scientific observation is that the fusional vergence reflex may be inadequate in the case of a low degree of heterophoria or of a high degree, and it may be adequate in the presence of a high degree of heterophoria or of a low.^{10,19} It will be evident from this, that the lateral heterophoria of itself bears no relation to reading ability or the performance of any other school work. It is of itself not an indication for referral.

Inadequacy of Fusional Vergence. In the vast majority of individuals lateral heterophoria is adequately compensated by the fusional vergence reflex. If the fusional vergence reflex is inadequate, the individual will have either symptoms (e.g., jumbling print or discomfort or "poor reading") or frank strabismus. Inadequate fusional vergence is faulty binocular coordination and requires referral and evaluation. It may cause word omission, repetition, or transposition in the line, ocular symptoms which are an indication for referral, regardless of tests, due to intermittent, transient, and frequently unrecognized, diplopia (double vision), or suppression of the vision of one eye. If suppression is unilateral, as it commonly is, acuity of vision will usually be impaired in that eye. In many cases it is subject to detection by the general medical examiner by observation of controlled convergence. Most children with disturbances of binocular vision are identifiable without a specific screening test for these conditions.

The problem has been to find the children who have inadequate fusional vergence but whose signs and symptoms have escaped detection. There is no screening test for inadequacy of the fusional vergence reflexes.*

*Sloane et al developed a fusional, prism vergence screening test, but found it unsatisfactory in practice.

Attempts have been made to detect these cases by screening for some predetermined degree of heterophoria.^{2-5,13,21,22} This has not proven satisfactory.

Most of the various functional binocular vision tests require medical interpretation and are frequently individually without meaning, and so without value for screening. Tests which are clinically valid for a function, and may contribute to diagnosis, such as "fusion tests," stereopsis or depth perception tests, are not correspondingly useful and valid for screening purposes. In the course of his examination, the ophthalmologist frequently modifies such tests specifically to meet the needs of the individual patient. He evaluates heterophoria measurements in relation to other binocular tests,^{6,8-13,18-20} and all in the light of the medical findings as a whole.

Strabismus which is intermittent or of low degree may escape early observation. In such cases visual acuity may be normal and refractive error of a low order, so that the child passes the acuity test and the convex lens test. Distance lateral heterophoria testing will, however, permit the detection of cases of alternate suppression, which although generally associated with strabismus in some degree, frequently have normal acuity of vision. There is, therefore, some justification for the use of a dissociation test to detect these cases. When the test demonstrates suppression (failure to see with right eye and left eye simultaneously) the child should be referred. In the absence of suppression, the test may also be used to detect lateral deviation in excess of a chosen standard; among these will be some cases of intermittent strabismus. The test does not, however, distinguish between heterotropia (strabismus), which is a basis for referral, and heterophoria, which is not a basis for referral. Hence referral of these cases will lead to some over-referrals.

Hyperphoria or vertical heterophoria, varies within narrow limits in the normal. Small deviations may give rise to symptoms of discomfort of which the child complains, or signs which may be observed by parents or teacher or elicited by the ophthalmologist on examination. They are a significant factor in reading difficulty, giving rise to jumping of lines, repeating a line already read, and misplacement of a word to a line above or below. Such a disturbance in reading is an ocular symptom and should be recognized as an indication for referral for examination with-

out awaiting testing. Children with small degrees of hyperphoria which are not detected by these signs or symptoms, usually require functional testing for identification.

Vertical and lateral deviations may be detected by the use of *dissociation tests* employing either (a) the Maddox rod (in spectacle form) and a light source for a target, or (b) red-green spectacles and red-green targets, as suggested by Lancaster²³ or (c) selected charts in stereoscopic instruments, as introduced by Wells.²⁴ Modifications adapted to screening are available.

Failure of prompt simultaneous perception of target light and streak may contribute to difficulty in administering the Maddox rod test in screening. Lateral and vertical heterophoria are tested separately by that test. The red-green test and some of the stereoscopic tests screen simultaneously for lateral and vertical heterophoria.

Hyperphoria tests at the "optical distance of 20 feet" may be administered with any of the stereoscopic instruments. Physical proximity of charts in the stereoscope, although it modifies the lateral heterophoria responses, does not invalidate the test for vertical imbalance. If the head is tilted in the stereoscope, however, the prismatic effect of the convex lenses of the stereoscope introduces a substantial error in the test result.

In assaying the indication for including the hyperphoria test in screening, it should be noted that the condition to be detected is uncommon,* that when it occurs in association with reduced acuity of vision or with hyperopia, the child will have been identified for referral, and that when it does not, he may often be found by teacher and parent observation or medical inspection. "Muscle imbalance" tests can be given in less than one minute per child.

Referral Standards. There is no scientific basis for setting standards of referral for lateral heterophoria. Opinion has been summarized by Lancaster et al.²⁸ In the light of present knowledge, it is reasonable to pass children with less than 5 prism diopters of esophoria or exophoria. Further research will eventually establish more precisely the importance and usefulness of this test for referral. If the suggested standards are adopted and the test is applied only to children who pass acuity and convex lens tests, it will be applied to about 80% of the school population and the lateral heterophoria test will refer less than 2% of the population,^{3,22} some erroneously. If half of these referrals are errors, the over-referral rate will be about 1% of the school population.

*In a population of 700 school children, Sloane and Gallagher(21) found hyperphoria of 1.5 prism diopter or more in 2.6%, many of whom were identifiable by impaired acuity or by the convex lens test.

Hyperphoria (unlike lateral heterophoria) is of itself an indication for referral for medical opinion. Opinions will differ as to the degree justifying referral, but if greater than 1 prism diopter hyperphoria is the standard, it will be generally approved, and the test will refer less than 0.5% of the population.

There is no clear indication for the inclusion of a near point heterophoria test in screening.

5. Peripheral Vision

Impairment of peripheral vision in a child of school age is infrequent. When present, it will be due almost invariably to brain tumor or other neurological disease. Although impairment of peripheral vision will be of diagnostic significance to the eye physician, peripheral vision *screening* is not a suitable method for detecting neurological conditions. Neurological disease will usually reveal itself in other ways—possibly gait, personality, speech, urinary symptoms, but perhaps only by headache, double vision, or failure to pass the Snellen test. (Hence the importance of medical diagnosis before procurement of glasses.)

6. Color Vision Test

Defects of color vision are not an indication for referral in screening. There is no treatment for this hereditary deficiency. Knowledge of its presence may be of importance in choosing a career, and in certain school courses, for example chemistry. Standard tests, such as the pseudoisochromatic tests, are available. Color vision need not be tested more than once during the school years.

Order of Testing

Parent and teacher observations* should go on continuously and are always significant. Physical examination by the family physician or the school physician preferably should occur early in any program.

*Teachers should not be asked to render an opinion. Continuous teacher observation is not to be confused with teacher judgment of the entire class in the course of a few days or any other interval of time.

Functional screening tests need be applied thereafter only to those children in whom there has *not* been found any indication for referral by lay observations or medical inspection. In practice, however, for administrative reasons functional testing may be carried out on all children, hence on some whose need for referral will also be determined with greater significance by parent, teacher, or physician.

Sloane and Gallagher,²¹ in a population of 741 boys found visual acuity of the *poorer* eye (with glasses, if worn) to be 20/20 in 82 per cent. Of the 466 individuals who did not have glasses, 46 (about 6 per cent of the population) had 20/20 vision (so failed the test) with convex lenses of +1.50 diopters. Testing their total population they found hyperphoria of 1.5 prism diopters or more in 2.6 per cent. Using the same test Yasuna and Green identified about 9%, but Diskan,⁴ using +1.75 diopters lenses found 2.4 per cent of a population of 799 failed the convex lens test. In the same group 3 children (0.4 per cent) were found to have more than 1 prism diopter of hyperphoria.

The test with the highest functional significance should be applied first, and successive tests in like order. Hence, the distance visual acuity test should be done first and the convex lens test next, but only on those who pass the acuity test. Any binocular vision test should be applied only to those who pass the first two tests.*

The school physician should determine what tests are to be done in the specific school system. Ophthalmological consultation is always available.

Reporting the Test

Failure to find indication for referral does not establish that the child has no abnormality. Hence parents should not be told that a child has *passed a screening test*. No report should be sent to the parents unless the child is referred for examination. When examination is indicated, the report to parents should state that medical inspection has revealed an eye condition requiring further medical examination. Statements of visual acuity are not advisable. Test results under screening conditions may differ from the findings of the ophthalmologist on office examin-

*Conditions detected by the two preceding tests will modify the vergence. The heterophoria test, therefore, does not measure the same factor in children with uncorrected refractive errors as in children with no significant refractive error. Other screening tests as applied to a total population are similarly affected by other variables. The results must be clinically interpreted before statistical evaluation. In the North Carolina study(25) the results of stereoscopic screening tests alone were evaluated only statistically.

ation. Parents seeking confirmation from the eye physician of test results reported by the school may misinterpret such differences.

Instruments and Equipment

All charts and equipment designed for testing acuity of vision at a physical distance of 20 feet use letters or the symbol **E**, based on Snellen's principles. The minimum requirement is a chart providing the critical 20/20 and 20/30 lines, and the 20/40 line. (The 20/40 line will serve for instruction—the anxious child may do better if given the opportunity to read a line of larger letters first. The 20/15 line is required if children above the third grade are to be screened for difference in acuity of the two eyes). A chart with the symbol **E** in various positions is required for children in the lower grades who do not know the letters. The use of letters for children above the third grade will reduce the error which may result from guessing. Illumination should be standardized and not less than 20 foot candles.

Stereoscopic instruments* have been advocated from time to time for screening. The use of stereoscopic instruments, on the theory that these simplify tests and make them suitable for use by the layman, actually complicates the testing procedure by introducing sources of error inherent in the procedure itself. Despite the optical provisions of these instruments, they nevertheless actually present to the child a chart which he knows from immediate observation to be at a close physical distance. This involuntarily invokes reflex responses (proximal convergence and proximal accommodation), which may alter the test results from the mathematically calculated equivalent, and do so in a manner which varies from individual to individual (physiological variable), so that no computation can possibly be made to eliminate this source of error. The optical accuracy of the instrument does not influence this factor. It affects all tests performed with the stereoscope, except the test for hyperphoria.

*Several instruments designed to present test charts at an "optical" distance of 20 feet are modifications of the simple stereoscope. The stereoscope, an instrument commonly used for viewing 3-dimensional pictures, was invented by the physicist Brewster in 1849. Ophthalmologists have used the stereoscope for a hundred years, employing charts introduced by Javal, Holmes, Wells, and other eminent physicians, to supplement other methods of diagnostic examination.

A stereoscope is an optical instrument employing lenses and prisms which serve to place at an "optical distance" (usually remote), an optical image of a chart which is physically close, and which enables the viewer to observe with each eye an image similar to but different from that seen by the other, and commonly to see the images as a single picture—to "fuse" them. The ability to fuse images in the stereoscope quickly without training is a physiologic variable.

This need not mean that testing procedures employing stereoscopic instruments serve no useful purpose. It does mean that the validity of a given test may be less than that of the corresponding test not employing such instruments, and that the need for interpretation by the ophthalmologist is greater.

All stereoscopic instruments have standardized built-in illumination. Some have color vision tests. Charts supplied with stereoscopic instruments permit the testing of central vision, and theoretically at least, the convex lens test may be given with any of these instruments. Tests for hyperphoria and distance lateral heterophoria are customarily included.

Charts for other tests are often supplied with stereoscopic instruments. As has been noted, "fusion tests," depth perception tests, and near heterophoria tests are not valid or useful for screening. The use of clinically invalid tests leads to erroneous referral. This is not an error of the instrument. Such tests should not be used. Their availability should not be considered an indication for selecting the test or rejecting the instrument. (Manufacturers will frequently supply test cards to meet the specifications of the purchaser).

Stereoscopic instruments do not make available any valid referral test which is not available without the stereoscope, but they offer a different mechanical means of testing.

There is a need for further medical investigation of the stereoscopic instruments to evaluate the individual tests which when performed by non-stereoscopic methods are of proven value.

Effectiveness of Program

The final test of any screening program is its effectiveness in identifying the child who should be referred for ophthalmological evaluation. Screening methods have at times been criticized by physicians and by the public on the grounds of "over-referral" or "under-referral" without adequate consideration of what the basis for referral in a given study has been and what the bases may be.

The child who on examination is found not to require therapy cannot for that fact be considered as not requiring eye care. Standards for referral should not lead to the referral only of children requiring therapy. To adopt this principle, is to ascribe to screening programs a diagnostic value they can never have. Medical diagnosis of the need or lack of need for treatment is the very essence of eye care. The child should have the benefit

of it if there is any question on the basis of the intelligent observations of parents or teacher, of the finding of the family or school physician, or of the application of valid tests of functions.*

When a child has been referred because of signs or symptoms or because of findings on medical inspection, and then has been examined and found not to require treatment, he has not been erroneously referred, but properly referred. Regardless of all other findings, he has a positive history on examination. All such children require examination, diagnosis and advice.

An *over-referral* is the referral of a child with no evidence of ocular difficulty observable by teacher or parent, no voluntary complaint,** and no positive findings by the family physician or the school medical inspector, but who is identified for referral by a test, yet on examination by the ophthalmologist has no positive finding. Over-referral may result from the application of a screening test, but it cannot result from observation of symptoms (positive history) or from physical inspection by the physician (positive medical findings).

On the basis of experience it may be observed that tests for acuity of vision lead to few over-referrals if the test is done at a physical distance of 20 feet and failures are retested on another day. This will eliminate many of the errors that will result from emotional and environmental factors that interfere with a child's

*Crane, Scobee, Foote, and Green(26,27) reported a detailed study of a school population of 1,215 sixth and first grade students. All were examined by ophthalmologists. Thirty-one per cent of sixth grade students and 23 per cent of first grade students were found to "need eye care."

Several methods of screening were applied to the same population and the effectiveness of each total screening procedure (but not individual tests) evaluated by its accuracy in selecting the children who required treatment. The screening was charged with "incorrect referral" when it referred a child *not found to require treatment*. These "incorrect referrals" may be divided into two classes: (1) children who had signs, or symptoms, or, on examination, evidence of abnormality, but were found by the ophthalmologist to require no treatment; (2) children who had no signs or symptoms, and on examination were found to have no evidence of abnormality. The second class were needlessly referred. The first class would be considered correctly referred if, as the criterion for referral, one adheres to need for examination, diagnosis, and medical opinion — perhaps the ophthalmologist's most important services. (It is not implied and it may not be concluded that this factor accounts for the major portion of "incorrect referrals" of any one or several of the screening methods used in this study.)

- **Although accurate information is usually not obtainable when children are asked leading questions about symptoms, the symptoms of which they complain voluntarily are usually explainable and not to be dismissed.

normal performance of a functional test*. The convex lens used for testing can be chosen to refer only those children who have an hyperopic refraction which ophthalmologists agree should be evaluated. Children identified *only* by a test for hyperphoria are so few that the question of over-referral may be considered academic.

A characteristic of screening is *failure to refer* some who should be clinically examined. This "failure to refer" is inherent in screening. Nothing less than examination by the ophthalmologist will identify every child who needs his services. When a child who requires clinical evaluation is not identified for referral by the program, the program has made an error which can be called "false negative" or "under-referral."

The individual test should be designed to screen for a specific condition or impairment of function. It should not be expected to screen out other conditions, and failure to do so is not an "under-referral" for the test, as is failure to identify a child with a condition it is intended to detect.

The visual acuity test will not screen out the moderate hyperope, the convex lens test will not screen out the myope. They are not intended to and should not be expected to. So with every test. All proper tests combined will still have failures of referral if the program is limited to screening tests.

Evaluation of School Programs

Procedures and tests can be evaluated by reference to established medical standards, and to suitable criteria for screening tests (see page 13). The total percentage of referrals of any "battery" of tests is meaningless until one evaluates each individual test. Statistics must be not merely statistically significant, but must deal initially with data of clinical validity.

The determination of the validity of tests is a medical responsibility, as is the establishment of the referral standard in any test. The training and the supervision of the nurse, the teacher, or any other personnel who may administer the test are likewise the responsibility of the physician.

Any program will be most effective if it is applied under the

*Distraction due to other activities, testing after exposure to bright sunlight or after strenuous physical exercise, all affect the test adversely.

guidance of an ophthalmologist in a consulting capacity. Screening examinations or tests should never be carried out by him. His presence, as an expert, would suggest to parents that the screening procedure is a definitive ophthalmological examination. (For the same reason nonmedical refractionists or other personnel who might be confused with the ophthalmologist or be regarded as experts should not participate in screening.)

Reappraisal by the school physician, with ophthalmological consultation, may reveal improvements which can be effected, in existing programs, frequently without radical change.*

School-Physician-Parent Relations

Parents, school personnel, and the medical profession must all understand the nature and objective of the program, each individually the contribution which is his to make, and the role of the school physician (medical inspector) and his staff.

The Parents—Parents should clearly understand that theirs is the first responsibility. They should be informed as to the meaning of screening tests as contrasted with thorough diagnostic ocular examination. They must understand that failure to pass a screening test means merely that examination by the physician is indicated, and that observation of signs of ocular difficulty by parent, teacher, or school physician indicates examination in any case. The condition of the eyes and the vision, as in the case of the general condition, can be determined only by the examining physician and only he can determine whether treatment is necessary. Parents should not look to the school for this information.

An educational program to acquaint the parents with what to observe in their children is advisable. The importance of taking the child for examination when the need for this is reported by the school should be explained to the parents in advance.

The School—When the school institutes a program or con-

*A procedure manual for the school physician and those assisting him will be available to school authorities on request. Write the National Medical Foundation For Eye Care, 250 West 57th St., New York 19, N. Y.

templates changes in a program, it should proceed only after consultation with members of the medical profession. A sound program will screen those who should be evaluated, and not those who probably require treatment; there will be some referrals of children who, on examination by the physician, will be found not to require treatment. This must be understood by all. It should be pointed out to parents, especially when any new program is instituted.

The Medical Profession—Ophthalmologists should take precaution in the manner of their reporting negative examinations to the parents. The school should be credited with its efforts in case finding, rather than discredited for an occasional inevitable error of referral of a normal child, or for the referral of cases which prove not to require treatment. Conversely, when the ophthalmologist finds on examination of a child that medical care is required, and the child was not referred by the school, the physician can contribute to the parents' understanding by pointing out that screening procedures are not diagnostic and cannot be infallible.

The examiner should furnish the school necessary information about the child's eyes. The school needs to know:

1. that the examination has been done;
2. under what circumstances glasses are required in school, if this is the case;
3. what, if any, special consideration (e.g. seating in the classroom) or special teaching (e.g. program for partially-sighted) the child requires, and briefly why;
4. what limitations, if any, are placed on the child's activities and school attendance, and briefly why.

It is neither necessary nor desirable that the ophthalmologist render to the school a full medical report of his diagnostic procedures and therapy. They are without meaning unless interpreted by the physician and even then generally of no value to the educator. The administration, the teaching staff, and the guidance personnel want to know what, if any, limitations the child has and what the school can do to help. They will not be flattered by receiving a detailed technical medical report which

consumes time and attention and does not help the educator teach the child. In general the physician is not at liberty to reveal information without parental consent, reportable, communicable disease being an exception by legal provision. With consent, the physician should indicate that he will forward helpful, necessary information. Consent does not release him from the obligation to exercise discretion. He is bound by ethical and legal considerations concerning matters of confidential communication and privileged communication.

The medical profession should accept the responsibility for orienting the parents and school personnel as to what they should observe in the child's appearance and behavior. The parent-teacher association will welcome this contribution from the medical profession. The physician will be discharging an obligation to the general welfare of the community.

Followup

Nothing has been accomplished for the referred child if parents fail to take him for examination.* Where effective educational measures introduce the school eye health program, a better response will be obtained from the parents when examination of the eyes is advised. When the school fails to receive a report that the examination has been done, follow-up by the nurse is advisable. The school nurse is particularly qualified by training and public acceptance to acquaint the parents with the need and with their responsibility.

Summary

The school is concerned with finding the children who need eye care. No series of tests and no testing instrument alone will adequately identify those who should be referred.

The school eye program is but a part of the general school health program. Medical inspection of the eyes is an integral

*In the Orinda study(31) "a net correction of 6.2 per cent was achieved in a relatively well-to-do community."

part of the general physical inspection by the school physician. This includes external inspection, examination of ocular muscle function and convergence, and functional tests. The physician may delegate functional testing, preferably to the nurse, but remains responsible for supervision and any interpretation of results which may be required. In discharging these duties he is merely rendering in the school services the general physician and the pediatrician perform routinely in their offices.

Test of visual acuity is essential. The use of Snellen test types at a physical distance of twenty feet is the procedure of choice. The convex lens test is recommended. In the present state of our knowledge of screening, testing for lateral muscle imbalance at twenty feet (because it may uncover some cases of strabismus), and for vertical muscle imbalance, is justifiable and should be considered by the school physician with ophthalmological consultation. Elaborate equipment is not necessary.

The parents, if they have observed ocular signs or if the school health examination has indicated referral, are responsible for seeing that the child is examined. Determination of the need for referral is the responsibility of the school physician. The school should carry on an adequate follow-up program through the school nurse to be sure that the child who requires it has been examined. Diagnosis and determination of the need for treatment are functions of the examining physician. All have a common objective which will be more satisfactorily attained if each recognizes a responsibility to understand the duties of the others.

Periodic ophthalmological examination of every child is advisable and for this there is no substitute. This should begin in infancy to permit the early diagnosis which is essential to the prevention of one-eyed blindness. Until the public has been educated to this need, the screening program of the school will continue to be necessary.

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Glossary

- accommodation*—the ability of the eye to adjust the focus for near vision.
- acuity of vision*—the sharpness of vision, expressed in precise terms; refers to central vision.
- astigmatia*—a condition of the eye in which not all of the rays of light from a far distant object focus at one point, but instead focus unequally (astigmatism); some or none of the rays may focus on the retina.
- binocular vision*—the ability to see the same object with both eyes simultaneously and singly.
- central vision*—the ability to perceive and discriminate the details of objects.
- convergence*—the turning of the eyes toward each other to adjust for the distance of an object and direct both eyes to the object.
- diopter*—the metric unit of measurement of lenses used in ophthalmology. (See also prism diopter).
- diplopia*—double vision.
- dissociation test*—a test in which the fusion reflex that otherwise functions, is purposely not permitted to function, in order to determine the position the eyes assume under these test conditions; the eyes may both be directed toward the test target (orthophoria), or they may diverge or converge from that alignment (heterophoria).
- esophoria*—see heterophoria.
- exophoria*—see heterophoria.
- fusion*—the process which enables us to put together into single binocular vision the communications reaching the brain from each of the two eyes.
- fusional vergence*—see vergence.
- heterophoria*—failure of both eyes to maintain alignment on an object when fusion, which otherwise would maintain alignment and single binocular vision, is suspended; latent “muscle imbalance”.
- esophoria*—convergent heterophoria.
- exophoria*—divergent heterophoria.
- hyperphoria*—vertical heterophoria, one eye being directed higher than its fellow.
- hyperopia*—a condition of the eye in which rays of light from a far distant object fail to focus on the retina, reaching the retina before coming to a focus; “farsightedness”. The eye may sometimes adjust in part or even totally for this condition and see objects clearly, but the act of compensating may cause discomfort, or disturbance of binocular vision.
- muscle imbalance*—see heterophoria.
- myopia*—a condition of the eye in which rays of light from a far distant object focus in front of the retina; “nearsightedness”. The eye can not compensate for this condition to see any but near objects clearly.

ophthalmologist—a physician (doctor of medicine) specially qualified in ophthalmology, that branch of medicine which deals with the eye, its refraction, abnormalities and diseases, and the relation of the visual system to the *whole man*. The *visual system* includes the eyes and related structures and their motor and sensory pathways of the brain.

prism diopter—the metric unit of measurement of prisms used in ophthalmology.

ophthalmoscope—an instrument for examining the interior of the eye.

pseudoisochromatic color test—a series of patterns of colored spots, using in a given pattern a specific color and confusion colors.

refraction (ocular)—the refractive error of the eye, or the process of determining it.

refractive error—the measure of deviation from accurate focus of the eye, as in astigmatism, hyperopia, myopia; defect of focus.

skiascopy (skiametry)—an objective method of measuring the refraction of the eye by means of an instrument which directs a beam of light into the eye.

strabismus—a condition in which the two eyes are not both directed at an object, the one eye deviating toward or away from its fellow; hence, convergent strabismus (“cross-eyed”), or divergent strabismus (“wall-eyed”). “Squint” and “cast” are other terms for strabismus. Strabismus may be present all the time, intermittently, or only under certain conditions, for example, a particular direction of gaze, or when tired.

suppression—the condition in which the sensations from one eye are involuntarily and unconsciously ignored, or “suppressed”, by the nervous system. When strabismus is present, suppression prevents the double vision which would otherwise occur due to the malalignment of the eyes. Suppression over a period of time interferes with the normal development of the eye and with the development of normal binocular vision.

vergence—the reflex turning of the eyes (strictly, the visual axes of the eyes) toward or away from each other in response to specific stimuli.

accommodative vergence—vergence in response to accommodation as the stimulus.

fusional vergence—vergence in response to stimulation of the fusional receptors in the retina. (When measured with prisms, sometimes spoken of as *prism vergence*.)

proximal vergence—vergence in response to the knowledge of nearness or sense of nearness of an object.

tonic vergence—vergence in response to the basic stimuli of the nervous system which maintain normal muscle tone.

visual angle—the angle between lines drawn from a certain physiological point in the eye to the edges of an object looked at.

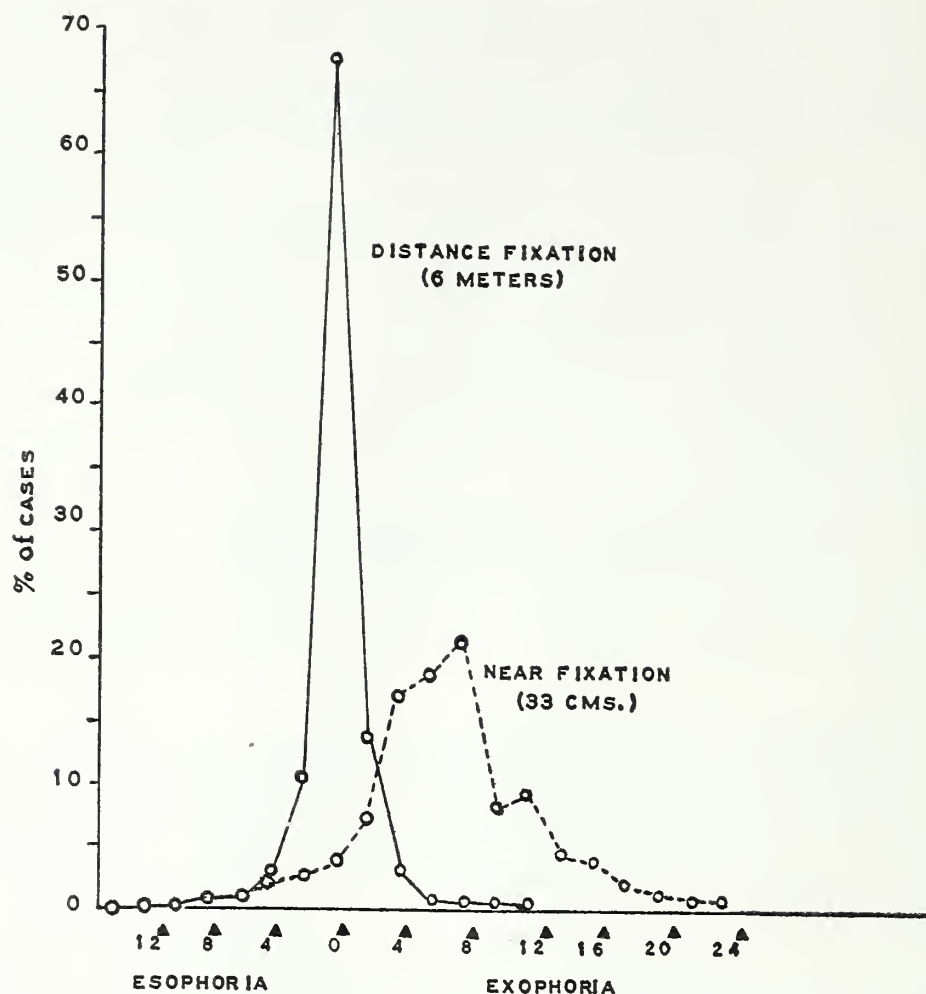


Fig. 1 (Tait). Distribution of heterophoria in 4,880 ocularly comfortable subjects.

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 250 West 57th Street, New York 19, N. Y.

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Executive Secretary

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